TECHNICAL REVIEWERS' COMMENTS
LRC-LIX-(59)–B

"Upgrade and Refurbishment of a Bench-Scale Entrained-Flow Slagging Gasifier"
Submitted by: Energy & Environmental Research Center;
Request for: $129,000; Total Project Costs: $354,000;
Principal Investigator: Jason Laumb; Project Duration: Seven Months

1. OBJECTIVES

The objectives or goals of the proposed project with respect to clarity and consistency with Industrial Commission/Lignite Research Council goals are: 1 - very unclear; 2 - unclear; 3 - clear; 4 - very clear; or 5 - exceptionally clear.

Reviewer 06-13 (Rating: 3)

The project goals and their relevancy to those of the NDIC/LRC are clear in that if the project is successful and leads to increased commercial activity, then economic benefits accrue to North Dakota and that is good. However, the extent to which the technology (entrained-flow gasification, or EFG) will or might contribute to any emerging commercial need and thus the potential market created by the research for the technology or the coal that it would use is not discussed. Similarly, if the successful conduct of the research leads to the removal of an impediment hindering penetration of a market or acceptance of the technology, the nature of the impediment and the increased market now available is not mentioned.

Reviewer 06-14 (Rating: 2)

The project goal is to upgrade and refurbish a drop-tube bench-scale gasifier to provide an operating regime representative of a high temperature entrained-flow slagging gasifier. The effort is a straight-forward mechanical upgrade. Experimental data would apparently not be produced following completion of the upgrade effort.

The proposed value to ND would be to increase future lignite utilization and jobs and allow for lignite use in existing commercially available gasifiers (slagging). The data would apparently be produced via a separate proposal.

Reviewer 06- 15 (Rating: 4)

Development of an advanced coal gasifier design that could successfully operate on ND lignite would present a significant opportunity for the State's future in coal-based energy development. The current "big name" gasifier licensors are spending very little effort to overcome the technical problems inherent to gasifying lignite in their respective units. The stated purpose of this research project at EERC could help by providing a device in which tests could be run to help mitigate those design issues.

2. ACHIEVABILITY

With the approach suggested and time and budget available, the objectives are: 1 - not achievable; 2 - possibly achievable; 3 - likely achievable; 4 - most likely achievable; or 5 - certainly achievable.

Reviewer 06-13 (Rating: 4)

A budget of 2,700 labor hours over seven months and a budget of $354,000 should easily accomplish the project objectives.

Reviewer 06-14 (Rating: 3)

The proposed project is primarily a mechanical upgrade and refurbishment to maintain high pressure and temperatures up to 3000 C. Additional emission capture equipment would also be included in the upgrading effort.

Reviewer 06-15 (Rating: 3)

It would be my sense that the budgeted research dollars will be adequate to refurbish the test gasifier described in the proposal.

3. **METHODOLOGY**

The quality of the methodology displayed in the proposal is: 1 - well below average; 2 - below average; 3 - average; 4 - above average; or 5 - well above average.

Reviewer 06-13 (Rating: 3)

The work statement objectives of design, construct and operate are standard. The proposal provides no further insight into unique design features, significant problems to be overcome, or "nifty" features to be incorporated in the proposed system. Assuming that a continuation proposal will be written for an operational program to follow, it would be useful to know that this redesign will provide an experimental system capable of handling the follow-on program with ease.

Reviewer 06-14 (Rating: 4)

EERC designed and constructed the original bench-scale drop tube gasifier and is fully capable of upgrading to higher pressures and temperatures.

Reviewer 06-15 (Rating: 4)

The specific details envisioned to refurbish and make operable the test gasifier are in sufficient detail that successful execution of the plan is likely to occur as proposed.

4. **CONTRIBUTION**

The scientific and/or technical contribution of the proposed work to specifically address Industrial Commission/LRC goals will likely be: 1 - extremely small; 2 - small; 3 - significant; 4 - very significant; or 5 - extremely significant.

Reviewer 06-13 (Rating: 3)

The gasification of low-rank coals using EFG could be the preferred technology when the desired products are a synthesis gas for chemical or hydrogen production. Technical information and data that enable this option to be evaluated could be quite useful.

Reviewer 06-14 (Rating: 2)

The ND lignite industry is currently working with commercial gasifier vendors.

The EERC proposal addresses only mechanical upgrades to an existing apparatus to address high pressure and temperature slagging gasifiers using lignite coal for future applications.

EERC is very knowledgeable concerning sodium, moisture and other constituent issues using lignite, which apparently would be addressed in a future effort. Commercial entrained slagging vendors should be a participant in the project.

However, the industry focus appears to be on low-temperature entrained gasifiers that would not suffer the issues that high-temperature slagging gasifiers might expect using ND lignite.

Reviewer 06-15 (Rating: 4)

Should the refurbished test gasifier lead to eventual success in reliable operation of entrained flow gasifiers on ND lignite, then the return on investment potential would be akin to having bought 100 shares of Google stock 10 years ago. However, the complex physical chemistry and mechanical engineering challenges to be overcome in future research with the refurbished gasifier are very significant. A positive outcome is by no means assured, though progress is likely to be made with this new device available to conduct the research.

5. **AWARENESS**

The principal investigator's awareness of current research activity and published literature as evidenced by literature referenced and its interpretation and by the reference to unpublished research related to the proposal is: 1 - very limited; 2 - limited; 3 - adequate; 4 - better than average; or 5 - exceptional.

Reviewer 06-13 (Rating: 3)

The proposal establishes that a paucity of data exists and that the proposed equipment refurbishment will provide facilities for addressing that deficiency.

Reviewer 06-14 (Rating: 5)

The EERC has an excellent national and international reputation in many power and environmental areas and an exceptional knowledge of ND lignite.

Reviewer 06-15 (Rating: 4)

The statement of purpose to undertake the refurbishment of this gasifier is based on a real need – obviously recognized by the principal investigator.

6. **BACKGROUND**

The background of the investigator(s) as related to the proposed work is: 1 - very limited; 2 - limited; 3 - adequate; 4 - better than average; or 5 - exceptional.

Reviewer 06-13 (Rating: 4)

The proposed project staffing ranges from very senior to junior. The PI's resume indicates intelligence and initiative, and the senior staff research manager has impeccable credentials. I don't believe staff performance will be a problem.

Reviewer 06-14 (Rating: 4)

The proposed work is focused on upgrading an existing bench-scale drop tube gasifier to provide high pressure and temperature that would address lignite constituents that contribute to operational issues. See comments provided in criteria # 4 above.

Reviewer 06-15 (Rating: 5)

There is perhaps nowhere else in the United States where the type of work described in the funding request can be more successfully executed than at the EERC. The resumes of the principal investigator and his associates make that evident.

7. PROJECT MANAGEMENT

The project management plan, including a well-defined milestone chart, schedule, financial plan, and plan for communications among the investigators and subcontractors, if any is: 1 - very inadequate; 2 - inadequate; 3 - adequate; 4 very good; or 5 - exceptionally good.

Reviewer 06-13 (Rating: 3)

The management plan presented provides the information needed without details or embellishment and is thus adequate but not exceptional.

Reviewer 06-14 (Rating: 3)

All activities would be conducted within EERC with periodic discussions with project sponsors.

Reviewer 06-15 (Rating: 4)

Refurbishment of the test gasifier does not appear to be an exceptionally complex project, and it would appear that the project plan and budget submitted should be adequate to ensure success.

8. EQUIPMENT PURCHASE

The proposed purchase of equipment is: 1 – extremely poorly justified; 2 – poorly justified; 3 – justified; 4 – well justified; or 5 – extremely well justified. (Circle 5 if no equipment is to be purchased.)

Reviewer 06-13 (Rating: 2)

Unjustified might be a better response, however, since NDIC is not being asked to buy any equipment, I can't assess to what extent that poses a problem. Certainly, the industrial share and the NCHT share will have considerable review and competent "buy-in".

Reviewer 06-14 (Rating: 5)

No equipment would be purchased with NDIC funds.

Reviewer 06-15 (Rating: 4)

It is evident that new hardware for the refurbishment is necessary. The fairly detailed inventory of this hardware would indicate that sufficient thought has been deployed to ensure there will be few surprises or 'budget busters' in this project.

9. **FACILITIES**

The facilities and equipment available and to be purchased for the proposed research are: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – notably good; or 5 – exceptionally good.

Reviewer 06-13 (Rating: 3)

The proposal discusses a novel, but un-described, heating system thus leaving its adequacy in doubt. The gasifier sketch and the equipment list suggest an inductively heated unit which, if properly designed, should be quite adequate.

Reviewer 06-14 (Rating: 3)

No comment.

Reviewer 06-15 (Rating: 3)

EERC's facilities are excellent. The inventory of equipment listed that is necessary to execute the project appears adequate.

10. **BUDGET**

The proposed budget "value" [1] relative to the outlined work and the financial commitment from other sources [2] is of: 1 - very low value; 2 - low value; 3 - average value; 4 - high value; or 5 very high value.

Reviewer 06-13 (Rating: 4)

NDIC is only being asked to pay 36% of the project cost which is a bargain. The project is well-leveraged with industrial and USDOE support and the gasifier will be an important piece of equipment to be included in the National Center for Hydrogen Technology.

Reviewer 06-14 (Rating: 2)

The proposed project would upgrade and refurbish an existing bench-scale unit and would not produce research data (which would require future funds).

The NDIC funds would support direct labor (& fringe benefits), minor supplies, and a facility and administrative costs that represent roughly 1/3 of the total project cost.

Although two industrial participants are anticipated, no commitment letters were included in the proposal.

Reviewer 06-15 (Rating: 4)

By utilizing on-site used hardware as a framework upon which to construct the new gasifier, it would appear to me that the proposed investment will return 'high value' relative to the alternative of starting from scratch and building the test gasifier. Matching funding from two industry sources adds further credibility to the potential value of the contribution requested of NDIC.

[1] "Value" – The value of the projected work and technical outcome for the budgeted amount of the project, based on your estimate of what the work might cost in research settings with which you are familiar.

[2] Financial commitment from other sources – A minimum of 50% of the total project must come from other than Industrial Commission sources to meet the program guidelines. Support greater than 50% from Industrial Commission sources should be evaluated as favorable to the application.

OVERALL COMMENTS AND RECOMMENDATION:

Please comment in a general way about the merits and flaws of the proposed project and make a recommendation whether or not to fund.

Reviewer 06-13 (Rating: FUND)
Whether or not one is a believer in the Hydrogen Economy, a National Center for Hydrogen Technology is in the national interest as it can provide the gasification technology needed for steam and power generation and the hydrogen and fuel gas needed for heavy oil upgrading. The technology being developed here will be an essential component of that activity and is worth supporting.

The proposal itself is very brief and non-technical and that lowers its score in the overall ranking matrix, but does not diminish the need for the project or its value to the NCHT. I recommend funding.

Reviewer 06-14 (Rating: DO NOT FUND)

The EERC is proposing to upgrade an existing bench-scale drop tube reactor that would provide high temperatures and pressures not previously achievable. The temperatures would exceed 1500 C, representative of a slagging gasifier. Commercial vendors of entrained flow slagging gasifiers have not successfully used ND lignite. Instead, low-temperature (non-slagging) entrained flow gasifiers, such as the DOE supported transport reactor TRIG concept being developed at DOE's Wilsonville facility (among others).

However, ND lignite constituents, sodium in particular, are problematic commercial issues.

The proposed EERC process upgrades are of low value without producing data with commercial vendor(s) and ND industrial participation.

Reviewer 06-15 (Rating: FUND)

Refurbishing and assembly of the test entrained flow gasifier does not appear to be an overly complex task.
It is not obvious, however -- and will not become apparent until well after testing commences, whether the design put forward will be capable of the scope of testing required to allow successfully gasifying lignite in entrained flow gasifiers. The very small scale of the test unit – as with nearly all research-scale units – will likely present operational challenges which will later require verification in a larger-scale unit.

Since the 'big name' gasifier vendors have not been forthcoming with a solution for employing ND lignite in their designs, it would appear we must try to help ourselves in this effort. The test unit proposed in this funding request could prove beneficial to unlocking the door to a brighter future for our lignite resources.

I would recommend funding the project.